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U.S. PATENT DOCUMENTS

PAT-NO	ISSUE-DATE	PATENTEE-NAME	US-CL
4975906	December 1990	Takiyasu et al.	370/85.13
5060228	October 1991	Tsutsui et al.	370/85.13
5280476	January 1994	Kojima et al.	370/60.1
5329527	July 1994	Ujihashi et al.	370/85.13
5420858	May 1995	Marshall et al.	370/60.1

FOREIGN PATENT DOCUMENTS

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ABSTRACT:

A device and a scheme for realizing the bridge interconnection in the ATM network efficiently. In the bridge device, a MAC frame transmitted from the interface with respect to the ATM network is transmitted selectively to either a point-to-point ATM connection interconnecting this bridge device and another bridge device or a multicast ATM connection interconnecting this bridge device and other bridge devices, while MAC addresses and identifiers of point-to-point ATM connections are registered in correspondences in a **table**. In a case this bridge device directly accommodates emulation hosts for emulating another non-ATM network through ATM connections having this bridge device as a starting point, a type of a MAC frame entered from the interface with respect to the ATM network is identified as either a MAC frame transmitted from any of the emulation hosts or a MAC frame transmitted from another bridge device connected with this bridge device by a bridge connection through the ATM network, and the MAC frame entered from the interface is transmitted selectively to ATM

connections of the ATM network according to the identified type.

22 Claims, 19 Drawing figures

ABPL:
A device and a scheme for realizing the bridge interconnection in the ATM network efficiently. In the bridge device, a MAC frame transmitted from the interface with respect to the ATM network is transmitted selectively to either a point-to-point ATM connection interconnecting this bridge device and another bridge device or a multicast ATM connection interconnecting this bridge device and other bridge devices, while MAC addresses and identifiers of point-to-point ATM connections are registered in correspondences in a **table**. In a case this bridge device directly accommodates emulation hosts for emulating another non-ATM network through ATM connections having this bridge device as a starting point, a type of a MAC frame entered from the interface with respect to the ATM network is identified as either a MAC frame transmitted from any of the emulation hosts or a MAC frame transmitted from another bridge device connected with this bridge device by a bridge connection through the ATM network, and the MAC frame entered from the interface is transmitted selectively to ATM connections of the ATM network according to the identified type.

BSPR:
(4) As for the broadcast frame mentioned in (3) above, it is possible to consider a scheme for constructing a spanning tree having all the bridge devices which are participating in the bridge interconnection as the starting points, and transmitting the broadcast frame by using the broadcast channel of the spanning tree configuration. However, such a scheme requires as many spanning trees as the number of bridge interconnections participating in the bridge interconnection, and this in turn requires very complicated management, initial setting, and deletion of **tables** for the spanning trees.

BSPR:
According to one aspect of the present invention there is provided an ATM bridge device for bridging between a first communication network operated in an ATM scheme and a second communication network operated in a non-ATM scheme, comprising: a first interface for exchanging signals with the first communication network; a second interface for exchanging signals with the second communication network; first transmission means for judging whether a host having a destination address of a MAC frame entered from the second interface exists in the second communication network, transmitting the MAC frame entered from the second interface to the first interface when it is judged that the host having the destination address of the MAC frame entered from the second interface does not exist in the second communication network, and transmitting a MAC frame transmitted from the first interface selectively to one of a point-to-point ATM connection interconnecting said ATM bridge device and another ATM bridge device and a multicast ATM connection interconnecting said ATM bridge device and other ATM bridge devices; second transmission means for transmitting the MAC frame entered from the first interface to the second interface; and **table** means for storing MAC addresses and identifiers of point-to-point ATM connections in correspondences by registering a source address of each MAC frame entered from the first interface and an identifier of a point-to-point ATM connection corresponding to said each MAC frame.

BSPR:
According to another aspect of the present invention there is provided a method for bridging between a first communication network operated in an ATM scheme and a second communication network operated in a non-ATM scheme, comprising the steps of: (a) providing a first interface for exchanging signals with the first communication network and a second interface for exchanging signals with the second communication network in an ATM bridge device between the first and second communication networks; (b) judging whether a host having a destination

address of a MAC frame entered from the second interface exists in the second communication network, and transmitting the MAC frame entered from the second interface to the first interface when it is judged that the host having the destination address of the MAC frame entered from the second interface does not exist in the second communication network; (c) transmitting a MAC frame transmitted from the first interface selectively to one of a point-to-point ATM connection interconnecting said ATM bridge device and another ATM bridge device and a multicast ATM connection interconnecting said ATM bridge device and other ATM bridge devices; (d) transmitting the MAC frame entered from the first interface to the second interface; and (e) storing MAC addresses and identifiers of point-to-point ATM connections in correspondences in **table** means by registering a source address of each MAC frame entered from the first interface and an identifier of a point-to-point ATM connection corresponding to said each MAC frame.

DRPR:
FIG. 11 is a block diagram of an internal configuration of a LAN emulation **server** in the system of FIG. 8.

DRPR:
FIG. 12A and FIG. 12B are flow charts for an operation of the LAN emulation **server** of FIG. 11.

DEPR:
Here, the point-to-multipoint ATM connection in the ATM network 10 can be realized by either a centralized scheme for using a multicast **server** within the ATM network 10 or a distributed scheme for constructing a spanning tree with the exchangers as nodes.

DEPR:
In this first embodiment, the bridge device 11 has an internal configuration shown in FIG. 3, which has an ethernet side physical interface unit 21 connected with the ethernet LAN 1A and an ATM network side physical interface unit 27 connected with the ATM network 10. Between them, for handling the data flow from the ethernet side to the ATM network side, there are provided a MAC address referring unit 22, a MAC address filtering unit 23, an ATM-MAC frame formation unit 24, and an AAL/ATM layer transmission processing unit 26, and for handling the data flow from the ATM network side to the ethernet side, there are provided an AAL/ATM layer reception processing unit 2A, an ATM-MAC address referring unit 2B, a MAC address filtering unit 2C, and a MAC frame formation unit 2D. In addition, an ethernet side MAC address **table** 24 is provided with respect to the MAC address referring unit 22 and the MAC address filtering unit 23, an ATM network side MAC address **table** 2F is provided with respect to the AAL/ATM layer transmission processing unit 26, the ATM-MAC address referring unit 2B, and the MAC address filtering unit 2C, and a bridge identification **table** 2E is provided with respect to the AAL/ATM layer reception processing unit 2A and the ATM network side MAC address **table** 2F. The detailed functions of each of these elements of the bridge device 11 will be explained below.

DEPR:
At the MAC address referring unit 22, the source MAC address in the internal MAC frame is referred, and when this source MAC address is a MAC address which has not been received before, this source MAC address is registered into the ethernet side MAC address **table** 24 (step 32). Thus, the ethernet side MAC address **table** 24 registers all the MAC addresses of the hosts existing on the ethernet 1A side which have been recognized by the bridge device 11 up until each moment.

DEPR:
The internal MAC frame is then handed over to the MAC address filtering unit

23. Here, whether the destination address of the internal MAC frame is registered in the ethernet side MAC address **table** 24 or not is checked (step 33). If it is registered there, it can be judged that the host to be the destination of the received MAC frame is existing on the ethernet 1A side, so that the internal MAC frame is discarded here (step 84). On the other hand, if it is not registered there, it is judged that there is a possibility for the host to be the destination of the received MAC frame to be existing on the ATM network 10 side (step 85), and the internal MAC frame is handed over to the ATM-MAC frame formation unit 25. By means of this configuration, there is no need to transmit the unnecessary MAC frame to the ATM network 10 side, so that the unnecessary traffic in the ATM network 10 can be suppressed.

DEPR:
The ATM-MAC frame formed at the ATM-MAC frame formation unit 25 is then ATM cell assembled at the AAL/ATM layer transmission processing unit 26. At this point, as a type of the AAL, the ALL type 5 may be used. This AAL/ATM layer transmission processing unit 26 carries out the ATM cell assembling by referring to the ATM network side MAC address **table** 2F to be described below.

DEPR:
Here, the ATM network side MAC address **table** 2F is a **table** having the MAC addresses and the cell header values as elements, and as the cell header value in this **table**, there is a case of entering the VPI/VCI value of the multicast ATM connection having the bridge device containing this **table** as a starting point and all the other bridge devices which are bridge interconnected with this bridge device as ending points, and a case of entering the VPI/VCI value of the point-to-point ATM connection. Here, the initial value of the cell header value in this ATM network side MAC address **table** 2F is set to be the cell header value of the multicast ATM connection. By means of this setting, even for the MAC frame destined to the MAC address for which the learning as described below is not yet completed in this ATM network side MAC address **table** 2F, it is possible to guarantee the arrival of that MAC frame at the destination host by transmitting that MAC frame through the multicast ATM connection, because the MAC frame transmitted through the multicast ATM connection reaches to all the bridge devices.

DEPR:
The AAL/ATM layer transmission processing unit 26 refers to the ATM network side MAC address **table** 2F by using the destination MAC address of the ATM-MAC frame to be transmitted to the ATM network 10 side as a key, and fetches the cell header value (VPI/VCI value) to be attached to the ATM cells.

DEPR:
Here, when the cell header value fetched from the ATM network side MAC address **table** 2F is the VPI/VCI value of the point-to-point ATM connection, i.e., when the destination MAC address is not a broadcast address (step S37 NO) and the VPI/VCI value of the point-to-point ATM connection is registered as the cell header value for the destination MAC address in the ATM network side MAC address **table** 2F (step 38 YES), the ATM cell assembling by attaching that cell header value is carried out (step 3A), and the ATM cell assembled MAC frame is transferred to the bridge device which directly accommodates the destination host through that point-to-point ATM connection (step 3C).

DEPR:
On the other hand, when the cell header value fetched from the ATM network side MAC address **table** 2F is the VPI/VCI value of the multicast ATM connection, i.e., when the destination MAC address is a broadcast address (step 37 YES) or the VPI/VCI value of the point-to-point ATM connection is not registered as the cell header value for the destination MAC address in the ATM network side MAC address **table** 2F (step 38 NO), the VPI/VCI value of the point-to-multipoint ATM connection is registered as the cell header value corresponding to the

destination MAC address in the ATM network side MAC address **table** 2F (step 39), the ATM cell assembling by attaching the cell header value of the multicast ATM connection is carried out (step 3B), and the ATM cell assembled MAC frame is transmitted to all the bridge devices through the multicast ATM connection (step 3C).

DEPR:
Here, at the receiving side bridge device, by recognizing the multicast ATM connection from which the entered MAC frame has arrived, it is possible to register that MAC frame along with the cell header value of the point-to-point ATM connection into the ATM network side MAC address **table** 2F on that bridge device.

DEPR:
In order to prevent such a transmission of the MAC frame to the bridge devices which do not accommodate the host to be the destination of that MAC frame, the transmitting side bridge device may also transmit an MAC frame called inquiry frame which urges the return of the MAC frame destined to that transmitting side bridge device from the receiving side host which has the destination MAC address of that MAC frame, in order to identify the correspondence relationship between that MAC address and the cell header value of the point-to-point ATM connection to the bridge device which is accommodating the host having that MAC address. For such an Inquiry frame, the ARP (**Address Resolution** Protocol) request packet or the In-ARP (Inverse ARP) request packet can be used.

DEPR:
In response, the receiving side host which received this inquiry frame then transmits the MAC frame called inquiry response frame with the MAC address of itself as the source MAC address and the MAC address of the transmitting side bridge device as the destination MAC address. The bridge device accommodating that receiving side host then transmits that inquiry response frame to the ATM network 10 side. At this point, the learning of the ATM network side MAC address **table** 2F should have already been completed, and therefore that MAC frame should be transmitted to the transmitting side bridge device through the point-to-point ATM connection, but it may be possible to transmit that MAC frame through the multicast ATM connection.

DEPR:
The transmitting side bridge device which received this inquiry response frame can then register the correspondence of the MAC address and the cell header value of the point-to-point ATM connection in the ATM network side MAC address **table** 2F by referring to the source address of the received inquiry response frame, so that the MAC frame with this destination MAC address can be transferred through the point-to-point ATM connection subsequently.

DEPR:
While such an operation for actively transmitting the inquiry frame is carried out, the transmitting side bridge device may transmit the MAC frame with the destination MAC address which has not yet been registered in the ATM network side MAC address **table** 2F at that moment through the multicast ATM connection. Else, the transmitting side bridge device may keep the MAC frame with the destination MAC address under the inquiry awaiting therein while the inquiry frame is transmitted, and transmit that MAC frame through the point-to-point ATM connection after the inquiry response frame arrives and that destination MAC address is registered in the ATM network side MAC address **table** 2F. In the latter case, the MAC frames to be transmitted through the multicast ATM connection will be reduced further, so that the further reduction of the traffic at the bridge device becomes possible. In addition, it is also possible to prevent an occurrence of The reversal of the orders by which the MAC frames arrive at the receiving side bridge device.

DEPR:

It is noted here that this operation may be carried out only in a case of receiving a plurality (two for example) of the MAC frames which are destined to the destination MAC address for which the cell header value of the point-to-point ATM connection is not registered in the ATM network side MAC address **table** 2F. In this manner, it is possible to register only those MAC addresses for which the exchanges among the bridge devices take places frequently, so that the ATM network side MAC address **table** 2F can be used more effectively.

DEPR:
For the receiving side bridge device, as many as [(total number of the bridge devices in the ATM network 10)-1] of the point-to-point ATM connections having that receiving side bridge device as an ending point and as many as [(total number of the bridge devices in the ATM network 10)-1] of the multicast ATM connections having that receiving side bridge device as one of ending points are provided. Here, the point-to-point ATM connection and the multicast ATM connection always come in pair. That is, there always exist the point-to-point ATM connection and the multicast ATM connection which have the same bridge device as their starting point. The bridge identification **table** 2E is a **table** of correspondence between the cell header values of such a pair of ATM connections. By referring to this bridge identification **table** 2E, it is possible to learn the cell header value of the point-to-point ATM connection which is connected to the bridge that is a starting point of the multicast ATM connection. The registration into this bridge identification **table** 2E can be carried out at a time of the activation of the bridge, or at a time of the establishment of the ATM connection, for example.

DEPR:
At this point, the received cell header value (VPI/VCI value) is also notified to the bridge identification **table** 2E. At the bridge identification **table** 2E, whether the received cell header value (VPI/VCI value) is the cell header value of the multicast ATM connection or not is checked (step 44), and when it is the cell header value of the multicast ATM connection, the cell header value of the corresponding point-to-point ATM connection having the same starting point is handed over to the ATM network side MAC address **table** 2F (step 45). Also, when the received cell header value is the cell header value of the point-to-point ATM connection, that cell header value is handed over to the ATM network side MAC address **table** 2F as it is.

DEPR:
At the ATM-MAC address referring unit 2B, the source MAC address of the received ATM-MAC frame is referred, and when it is the MAC address which has not been received before, registers this source MAC address into the ATM network side MAC address **table** 2F (step 46). At this point, it should be noted that the source MAC address is registered in the ATM network side MAC address **table** 2F by being paired with the cell header value of the point-to-point ATM connection notified from the bridge identification **table** 2E at the same time. Also, in a case the source MAC address of the received ATM-MAC frame is registered in the ethernet side MAC address **table** 24, this address is deleted from the ethernet side MAC address **table** 24 (step 47).

DEPR:
As described above, the ATM network side MAC address **table** 2F has the MAC address and the VPI/VCI value of the ATM connection which is connected to the bridge device accommodating the host having that MAC address as the entry data. In this manner, the bridge device comprehends the correspondence relationship of each ATM connection and the transmitting side bridge device, so that by referring to the ATM network side MAC address **table** 2F, it is possible to learn which host having which MAC address is connected with which bridge device. Thus, this ATM network side MAC address **table** 2F can be utilized when the AAL/ATM layer transmission processing unit 26 transmits the MAC frame by

specifying the cell header value of the ATM connection connected to the bridge device which accommodates the destination of that MAC frame In the flow from the ethernet to the ATM network side.

DEPR:
Also, the bridge device can learn the MAC address of the host existing on the ATM network side which has been recognized by that bridge device at that moment by looking through this ATM network side MAC address **table** 2F. This type of usage of the ATM network side MAC address **table** 2F will be made at the MAC address filtering unit 2C as will be described below.

DEPR:
The ATM-MAC frame is then converted into the format of the internal MAC frame at the ATM-MAC address referring unit 2B, and handed over to the MAC address filtering unit 2C. There, whether the cell header value of the point-to-point ATM connection corresponding to the destination MAC address of that internal MAC frame is registered in the ATM network side MAC address **table** 2F or not is checked (step 48), and when it is registered, it can be judged that the host to be the destination of that MAC frame is existing on the ATM network side, looking from the bridge device, so that this internal MAC frame is discarded here (step 49). On the other hand, when it is not registered, it is judged that there is a possibility for the host to be the destination of that MAC frame to be existing on the ethernet side (step 4A), and this internal MAC frame is handed over to the MAC frame formation unit 2D. By means of this configuration, there is no need to transmit the unnecessary MAC frame to .the ethernet side, so that the unnecessary traffic in the ethernet can be suppressed.

DEPR:
Here, in order to carry out the above operation quickly, a bit indicating whether the cell header value registered in the ATM network side MAC address **table** 2F is the cell header value of the point-to-point ATM connection or not may be provided as an additional entry.

DEPR:
In addition, by providing the learning mechanism as described above, it becomes possible to produce the correspondence **table** of the MAC address information and the cell header information (identification information of the point-to-point ATM connection connected to the bridge device accommodating the host having that MAC address) automatically.

DEPR:
Next, a case in which the moving host exists on the ethernet LANs 1A to 1D will be described. As an illustrative example, a case in which a host 51 on the ethernet 1D moves to the ethernet 1B as shown in FIG. 6 will be considered here. According to the above description, when the host 51 is existing on the ethernet 1D, the host 51 is registered in the ethernet side or the ATM network side MAC address **table** at each bridge device as indicated in FIG. 6. When this host 51 has moved from the ethernet 1D to the other ethernet (ethernet 1B in this example), as this host 51 is registered in each MAC **table** as indicated in FIG. 6, the MAC frame with the destination MAC address "#X" transmitted from any host other than those on the the ethernet 1B (such as a host 53) would not flow into the ethernet 1B because of the filtering according to the MAC address **table**. For instance, the MAC frame destined to the host 51 which has the ethernet 1A or 1C as a starting point would reach the bridge device 14 through the ATM connections 5A or 5B, and then transmitted to the ethernet 1D according to the MAC address **table** in the bridge device 14, so that this MAC frame would not reach to the destined host 51 after this host 51 has moved.

DEPR:
Even in a case the MAC address "#X" has not been registered in the ATM network

side MAC address **table** 2F at the bridge device 11 or 13 such that this MAC frame with this MAC address "#x" as the destination MAC address reaches to the bridge device 12 through the multicast ATM connection, this MAC address "#x" is registered in the ATM network side MAC address **table** 2F in the brides device 12, so that this MAC frame would be filtered out and discarded at the MAC address filtering unit 2C in the bridge device 12. Also, the MAC frame having the ethernet 1D as a starting point would be filtered out and discarded at the MAC address filtering unit 23 in the bridge device 14 as the MAC address "#x" is registered in the ethernet side MAC address **table** 24 in the bridge device 14.

DEPR:
In order to deal with such a moving host, the following function can be added to the above described first embodiment. Namely, the moved host tramsmits some MAC frame by using the broadcast address as the destination MAC address. Then, as the broadcast address is used as the destination MAC address, this MAC frame passes through the bridge device 12 and reaches to all the other bridge devices through the multicast ATM connection. At this point, the following operations are carried out. (1) If the source address of the MAC frame from the ethernet side is registered in the ATM network side MAC address **table** 2F, this source address is deleted from the ATM network side MAC address **table** 2F and registered into the ethernet side MAC address **table** 24. (2) If the source address of the MAC frame from the ATM network side is registered in the ethernet side MAC address **table** 24, this source address is deleted from the ethernet side MAC address **table** 24 and registered into the ATM network side MAC address **table** 2F along with the cell header value of the point-to-point ATM connection connected to the bridge device from which this MAC frame is received.

DEPR:
Here, in a case the ATM network side MAC address **table** 2F is separately provided for each bridge device, it is necessary to carry out the above operation (2) for registering the MAC address in the ATM network side MAC address **table** 2F by the two step procedure of deleting the old registered information first, and then registering the MAC address in the ATM network side MAC address **table** 2F corresponding to the bridge device from which this MAC frame is received.

DEPR:
On the other hand, by using only one ATM network side MAC address **table** 2F and providing an entry for information on the bridge device corresponding to the MAC address or information such as a virtual connection by which the bridge device can be identified, the rewriting procedure can be simplified to the overwriting of the information related to the bridge device alone, such that the efficient **table updating** can be realized.

DEPR:
For the reason described above, when a plurality of virtual connections are to be multiplexed in a single physical interface as in the ATM network, it is effective to provide an entry for information on the corresponding bridge device in the ATM network side MAC address **table** 2F, rather than providing a separate **table** for each corresponding bridge device.

DEPR:
By the above described **table updating** operation, a state of the MAC address **tables** is changed from that indicated in FIG. 6 to that indicated in FIG. 7. In the **updated** state of FIG. 7, the MAC frames with the destination MAC address "#x" are transferred to the bridge device 12 through the point-to-point ATM connections 61, 62, and 63. In this case, the processing sequences at each bridge device are substantially similar to those shown in FIGS. 4 and 5 described above.

DEPR:
In this second embodiment, the ATM communication system has an overall configuration as shown in FIG. 8, which comprises an ATM network 70, ethernet LANs 7A, 7B, and 7C which are non-ATM communication networks, a LAN emulation server 74 (abbreviated hereafter as an LE server) connected with hosts 7D, 7E, and 7F located within the ATM network 70, and bridge devices 71, 72, and 73 for making bridge interconnections between the ATM network 70 including the LE server 74 and the ethernet LANs 7A, 7B, and 7C, respectively, so as to construct an ATM bridge interconnection environment. Here, the ATM network 70 and the ethernet LANs 7A to 7C have functions similar to those in the first embodiment described above, except for the presence of the LE server 74 in the ATM network 70.

DEPR:
In this system of FIG. 8, the connections among the hosts connected with the ethernet LANs 7A to 7C and the LE server 74 are the bridge interconnections, so that the network layer address (such as the IP address) of these hosts have the same network address (net ID or sub-net ID). Here, the ATM network 70 also establishes a multicast ATM connection 93 as shown in FIG. 9 which has the LE server 74 as a starting point and all the bridge devices and any other LE servers (not shown) which are bridge interconnected as ending points, and point-to-point ATM connections which has the LE server 74 as a starting point and each of the bridge devices as ending points, in addition to the ATM connections as in the first embodiment described above.

DEPR:
Here, the hosts 7D to 7F connected with the LE server 74 behave as if they are connected with the ethernet LANs 7A to 7C, so that it can be said that the LAN emulation is realized in this system. For this reason, the hosts 7D to 7F connected with the LE server 74 can use the already existing software applications which presuppose the connection with the ethernet, without requiring any modification.

DEPR:
Now, each of the hosts 7D to 7F connected with time LE server 74 has an internal structure as shown In FIG. 10. In this second embodiment, each of the hosts 7D to 7F connected with the LE server 74 is recognizing itself as being connected with the ethernet or bridge interconnected with the ethernet, and for each packet to make the LAN emulation which is given by a network layer processing unit 81, a layer 3 packet (such as the IP packet) that is to be transmitted from that host to the external is loaded into the MAC frame and this MAC frame is ATM cell assembled, and then the assembled ATM cell is entered into the ATM network 70, while the packet arrives from the ATM network 70 in a form of a MAC frame.

DEPR:
This MAC frame is in a format agreed among all the LE servers and the bridge devices which are bridge interconnected, and generated at an ATM-MAC frame generation unit 82. This MAC frame will be referred as the ATM-MAC frame. In other words, the ATM-MAC frame is a MAC frame in a format by which the exchanges of the MAC frames are carried out among the bridge devices and the LE servers which are bridge interconnected in the ATM network.

DEPR:
Here, between each host and the LE server, one bidirectional ATM connection is provided such that the exchange of the MAC frame is carried out through this ATM connection. This host is recognizing an identifier (cell header value) of this ATM connection, and the ATM-MAC frame which is to be either transmitted from that host to the external or entered into that host from the external is going to pass through that ATM connection. An AAL/ATM layer transmission

processing unit 85 carries out the ATM cell assembling of the ATM-MAC frame and then sends the assembled ATM cell into this ATM connection through an ATM network side physical interface unit 86.

DEPR:
Next, the LAN emulation **server** 74 in this second embodiment will be described in detail.

DEPR:
In a case of realizing the bridge interconnections similar to those in the first embodiment described above, the LE **server** 74 has an internal configuration as shown in FIG. 11, and operates according to the flow chart of FIG. 12 as follows.

DEPR:
When the ATM cell assembled ATM-MAC frame is received at an ATM network side physical interface unit 101 (step 111), the ATM-MAC frame is reproduced from this at an AAL/ATM layer reception processing unit 102 (step 113), and handed over to an ATM-MAC address registration unit 103. At this point, the AAL/ATM layer reception processing unit 102 and the ATM-MAC address registration unit 103 refer to the cell header value and the source MAC address of the received cell and register them sequentially in a MAC address **table** 106, just as in a case of the registration of the ATM network side MAC address **table** 2F in the first embodiment described above (step 112). Here, however, the registration into the MAC address **table** 106 is omitted for the hosts 7D to 7F (also referred hereafter as LAN emulation hosts or LE hosts) which are directly supported by the LE **server** 74. This provision is adopted in order to prevent the ATM-MAC frame destined to the LE host from being always discarded by a destination MAC address filtering at a next MAC address referring unit 104. This provision of not registering the MAC address of the LE host in the MAC address **table** 106 can be actually implemented by a scheme of not carrying out the registration into the MAC address **table** 106 for those MAC addresses which are registered in an LAN emulation **table** (LE **table**) 107 to be described below.

DEPR:
Then, the MAC address referring unit 104 carries out the following operation. First, by referring to the LE **table** 107, whether the destination address of the MAC frame under processing is registered in the LE **table** 107 or not is checked (step 114). If the destination MAC address of the MAC frame under processing is registered in the LE **table** 107, it is judged that the destination indicated by this destination MAC address is the LE host (step 115), and the cell header value of the ATM connection connected to this LE host is fetched from the LE **table** 107, and the fetched cell header value and this MAC frame are sent to an AAL/ATM layer transmission processing unit 105, such that the AAL/ATM layer transmission processing unit 105 carries out the ATM cell assembling of this MAC frame by attaching this cell header value (step 116), and the assembled ATM cell is transmitted to the ATM network 70 at the ATM network side physical interface unit 101 (step 11H).

DEPR:
On the other hand, when the destination MAC address of the MAC frame under processing is not registered in the LE **table** 107, it is judged that either this destination MAC address is a broadcast address, or else the destination indicated by this destination MAC address is a host not directly accommodated by the LE **server** 74 (step 117). From here on, the processing differs for a case in which the host which transmitted this MAC frame is the LE host directly accommodated by the LE **server** and a case in which the host which transmitted this MAC frame is the bridge device or another LE **server** which is bridge interconnected with this LE **server** 74.

DEPR:

First, whether the source address of this MAC frame is registered in the LE **table** 107 or not is checked (step 118). Here, in a case the source address of this MAC frame is not registered in the LE **table** 107, this MAC frame is a MAC frame transmitted from the bridge device or another LE **server** which is bridge interconnected with this LE **server** 74. Consequently, whether the destination MAC address of this MAC frame is the broadcast address or not is checked (step 11E) next, and when this destination MAC address is not the broadcast address, this MAC frame is discarded (step 11F) because in this case it is guaranteed by referring to the LE **table** 107 that this LE **server** 74 does not accommodate the host having this destination MAC address. On the other hand, when this destination MAC address is the broadcast address, this MAC frame is ATM cell assembled at the AAL/ATM layer transmission processing unit 105 by attaching the cell header value for a transmission to all the LE hosts accommodated by this LE **server** 74 (step 11G), and the assembled ATM cell is transmitted to the ATM network 70 at the ATM network side physical interface unit 101 (step 11H) for the reason described below.

DEPR:
On the other hand, when the source address of this MAC frame is registered in the LE **table** 107 at the step 118, this MAC frame is a MAC frame transmitted from the LE host which is directly accommodated by this LE **server** 74. Consequently, whether the destination MAC address of this MAC frame is the broadcast address or not is checked (step 119) next, and when this destination MAC address is the broadcast address, this MAC frame is ATM cell assembled at the AAL/ATM layer transmission processing unit 105 by attaching the cell header value for a transmission to all the LE hosts accommodated by this LE **server** 74 and all the bridge devices and other LE **servers** which are beidge interconnected to this LE **server** 74 (step 11D), and the assembled ATM cell is transmitted to the ATM network 70 at the ATM network side physical interface unit 101 (step 11H). On the other hand, when this destination MAC address is not the broadcast address, the following operation similar to that in the first embodiment described above is carried out.

DEPR:
Namely, whether the destination MAC address of this MAC frame is registered in the MAC address **table** 106 or not is checked (step 11A), and in a case this destination MAC address is not registered, this MAC frame is ATM cell assembled at the AAL/ATM layer transmission processing unit 105 by attaching the cell header value for a transmission to all the bridge devices and other LE **servers** which are bridge interconnected to this LE **server** 74 (step 11C), and the assembled ATM cell is transmitted to the ATM network 70 at the ATM network side physical interface unit 101 (step 11H). On the other hand, when this destination MAC address is registered in the MAC address **table** 106, this MAC frame is ATM cell assembled at the AAL/ATM layer transmission processing unit 105 by attaching the cell header value registered in the MAC address **table** 106 (step 11B), and the assembled ATM cell is transmitted to the ATM network 70 at the ATM network side physical interface unit 101 (step 11H).

DEPR:
In this manner, it is possible to prevent such a MAC frame which has the broadcast address as the destination MAC address or which should carry out the broadcasting (referred hereafter as a broadcasting MAC flame) from being circulated indefinitely in the ATM network. Namely, if the broadcasting MAC frame which is transmitted from the other bridge device or LE **server** in the ATM network is returned (relayed) to the other bridge device or LE **server** side again, that other LE **server** is going to carry out the similar operation, and this broadcasting MAC frame is going to be transferred among the LE **servers** indefinitely.

DEPR:
As in the above, in this second embodiment, the source address of the MAC frame

received by the LE **server** is checked, and when it is a MAC frame from the other bridge device or LE **server** which is bridge interconnected to this LE **server**, or when it is not an LE host directly accommodated by this LE **server**, by transferring this MAC frame only to the LE hosts side and not to the other bridge devices or LE **servers** side, the occurrence of the above described indefinite loop can be prevented.

DEPR:
Here, in a case of making the bridge interconnection/LAN emulation as in FIG. 8 for example, the MAC frame which has the broadcast address or the MAC address not registered in the MAC address **table** 106 as the destination MAC address, the following provision may be adopted. Namely, by providing the multicast ATM connections 91, 92, and 93 as shown in FIG. 9, and:

DEPR:
(1) the MAC frame to be transferred to all the LE hosts directly accommodated by this LE **server** is transmitted with respect to the multicast ATM connection 92 (at the step 11G in FIG. 12);

DEPR:
(2) the MAC frame to be transferred to all the bridge devices and the other LE **servers** which are bridge interconnected to this LE **server** is transmitted with respect to the multicast ATM connection 93 (at the step 11C in FIG. 12); and

DEPR:
(3) the MAC frame to be transferred to all the LE hosts directly accommodated by this LE **server** and all the bridge devices and the other LE **servers** which are bridge interconnected to this LE **server** is transmitted with respect to the multicast ATM connection 91 (at the step 11D in FIG. 12).

DEPR:
As such, in a case of incorporating the LE **server** in the bridge interconnection in the ATM network, various types of broadcasting scheme are required depending on the source address of the MAC frame, and by providing various types of multicast ATM connections, it becomes possible to deal with a type of broadcasting scheme required in making the bridge interconnection of the LE **server** by simply using the multicast ATM connection that can be realized easily in the ATM network.

DEPR:
As for the LE hosts accommodated by this, LE **server**, the MAC addresses of these LE hosts and the cell header values of the point-to-point ATM connections connected to these LE hosts are registered in the LE **table** 107. The registration of this LE **table** 107 can be carried out at a time of activating or modifying the LE **server** or the LE hosts.

DEPR:
In this third embodiment, the bridge device 121 has an internal configuration shown in FIG. 14, which has an ethernet side physical interface unit 131 connected with the ethernet LAN 12A and an ATM network side physical interface unit 138 connected with the ATM network 120. Between them, for handling the data flow from the ethernet side to the ATM network side, there are provided a MAC address referring unit 132, a MAC address filtering unit 133, an ATM-MAC frame formation unit 135, an ATM-MAC frame multiplexing unit 136, and an AAL/ATM layer transmission processing unit 137, and for handling the data flow from the ATM network side to the ethernet side, there are provided an AAL/ATM layer reception processing unit 13A, an ATM-MAC source address referring/discarding unit 13B, an ATM-MAC destination address ethernet side filtering unit 13C, and a MAC frame formation unit 13D. In addition, an ethernet side MAC address **table** 134 is provided with respect to the MAC address referring unit 132 and the MAC address filtering unit 133, as well as the

ATM-MAC destination address ethernet side filtering unit 13C and the ATM-MAC source address referring/discarding unit 13B, where the ATM-MAC destination address ethernet side filtering unit 13C is connected with the ATM-MAC frame multiplexing unit 136. Here, the ethernet side physical interface unit 131, the MAC address referring unit 132, the MAC address filtering unit 133, the ethernet side MAC address **table** 134, and the ATM-MAC frame formation unit 135 have functions similar to the corresponding elements in the first embodiment described above.

DEPR:
In the flow chart of FIG. 15, the steps 141 to 146 are similar to the steps 31 to 36 in the flow chart of FIG. 4 for the first embodiment described above, except that the operation related to the ATM network side MAC address **table** 2F at the step 32 is omitted in the step 142.

DEPR:
At the MAC address referring unit 132, the source MAC address in the internal MAC frame is referred, and when this source MAC address is a MAC address which has not been received before, this source MAC address is registered into the ethernet side MAC address **table** 134 (step 142). Thus, the ethernet side MAC address **table** 134 registers all the MAC addresses of the hosts existing on the ethernet 12A side which have been recognized by the bridge device 121 up until each moment.

DEPR:
The internal MAC flame is then handed over to the MAC address filtering unit 133. Here, whether the destination address of the internal MAC frame is registered in the ethernet side MAC address **table** 134 or not is checked (step 148). If it is registered there, it can be judged that the host to be the destination of the received MAC frame is existing on the ethernet 12A side, so that the internal MAC frame is discarded here (step 144). On the other hand, if it is not registered there, it is judged that there is a possibility for the host to be the destination of the received MAC frame to be existing on the ATM network 120 side (step 145), and the internal MAC frame is handed over to the ATM-MAC frame formation unit 135.

DEPR:
At the ATM-MAC source address referring/discarding unit 13B, the source address of the received ATM-MAC frame is referred, and compared with the MAC addresses in the ethernet side MAC address **table** 134 (step 153). When this source address coincides with any of the registered MAC addresses, this ATM-MAC frame is judged as entered into the loop shaped group of ATM connections of the ATM network 120 with this bridge device as a starting point, so that this ATM-MAC frame is discarded here in order to prevent this ATM-MAC frame from being entered into the loop shaped group of ATM connections again to circulate through the loop indefinitely (step 154). On the other hand, when this source address does not coincide with any of the registered MAC addresses, this ATM-MAC frame is judged as entered into the loop shaped group of ATM connections of the ATM network 120 by another bridge device other than this bridge device, and there is a possibility for the destination host to be existing on the ethernet connected to this bridge device (step 155).

DEPR:
Then, the ATM-MAC frame is handed over to the ATM-MAC destination address ethernet side filtering unit 13C, which refers to the destination MAC address of this ATM-MAC frame and compares with all the MAG addresses registered in the ethernet side MAC address **table** 134 (step 156). If this destination MAC address is registered, it is judged that the destination host of this ATM-MAC frame is accommodated by this bridge device (step 157), so that there is no need to further transfer this ATM-MAC frame to the other bridge devices. For this reason, this ATM-MAC frame is transferred only to the MAC frame formation unit 13D and not to the ATM-MAC frame multiplexing unit 136. Here, if the

destination MAC address is the broadcast address or the multicast address, this ATM-MAC frame is not discarded here, and transmitted to the ATM-MAC frame multiplexing unit 136 as well.

DEPR:
In addition, an ethernet side MAC address **table** 174 is provided with respect to the MAC address referring unit 172 and the MAC address filtering unit 173, as well as the ATM-MAC source address referring/discarding unit 17B, where the ATM-MAC destination address ethernet side filtering unit 17C is connected with the ATM-MAC frame multiplexing unit 176, and a cell header value correspondence **table** 17E is provided with respect to the ATM-MAC frame multiplexing unit 176 and the AAL/ATM layer reception processing unit 17A. Here, the ethernet side physical interface unit 171, the MAC address referring unit 172, the MAC address filtering unit 173, the ethernet side MAC address **table** 174, and the ATM-MAC frame formation unit 175 have functions similar to the corresponding elements in the first embodiment described above, except that the ethernet side MAC address **table** 174 is also referred from the ATM-MAC source address referring/discarding unit 17B as well.

DEPR:
The ATM-MAC frame formed by the ATM-MAC frame formation unit 175 is then transmitted to the ATM-MAC frame multiplexing unit 176 which receives the ATM-MAC frames from the ATM-MAC frame formation unit 175 as well as the ATM-MAC destination address ethernet side filtering unit 17C and has a function of multiplexing these ATM-MAC frames and handing the multiplexed ATM-MAC frame to the AAL/ATM layer transmission processing unit 177. At this point, the ATM-MAC multiplexing unit 176 gives the cell header value of the ATM connection having this bridge device as a starting point among the group of ATM connections to the ATM-MAC frame transmitted from the ATM-MAC frame formation unit 175, and the cell header value obtained from the cell header value correspondence **table** 17E to be described below to the ATM-MAC frame transmitted from the ATM-MAC destination address ethernet side filtering unit 17C.

DEPR:
The ATM cell is received at the ATM network side physical interface unit 178, and after the physical layer processing is applied therein, and the ATM-MAC frame is reproduced at the AAL/ATM layer reception processing unit 13A by applying the ATM cell disassembling processing for each VPI/VCI value, and then handed over to the ATM-MAC source address referring/discarding unit 17B. Also, the cell header value (referred hereafter as the input cell header value) attached to this ATM-MAC frame is handed over to the cell header value correspondence **table** 17E.

DEPR:
The functions of the ATM-MAC source address referring/discarding unit 17B and the ATM-MAC destination address ethernet side filtering unit 17C are similar to the corresponding elements in the third embodiment described above. Here, however, the ATM-MAC frame transmitted from the ATM-MAC destination address ethernet side filtering unit 17C to the ATM-MAC frame multiplexing unit 176 is accompanied by the output cell header value outputted from the cell header value correspondence **table** 17E, and this output cell header value is attached to this ATM-MAC frame in the ATM cell assembling of this ATM-MAC frame.

DEPR:
Here, the cell header value correspondence **table** 17E is a correspondence **table** of the cell header value for the ATM connection from which the ATM-MAC frame is entering into this bridge device and the cell header value for the ATM connection to which the ATM-MAC frame is to be transmitted from this bridge device, for all the group of ATM connections which have this bridge device as a starting point and circulate through all the other bridges. Thus, in a case this bridge device is an ending point of the group of ATM connections, the

output cell header value of "null" is registered in this cell header value correspondence **table** 17E.

DEPR:
In this manner, the group of ATM connections in this fourth embodiment have the mutual correspondences set up in the cell header value correspondence **table** 17E of each bridge device, so that as long as the MAC frame can circulate through all the bridge devices, the direction of circulation can be set arbitrarily. By means of this, it becomes possible to set a busy bridge device which is making very frequency exchanges of the MAC frames on an upper stream side in the group of ATM connection such that the transmission of the unnecessary MAC frames in the lower stream side of this busy bridge device can be omitted as they are effectively absorbed at this busy bridge device, and consequently, it becomes possible to reduce the traffic in the ATM network as a whole. In addition, in a case of adding a new bridge device in the bridge interconnections, it is possible to set this new bridge device at the lower stream side of the group of ATM connections, such that the initial setting of the bridge interconnection participation can be made easily. Moreover, it is also possible to dynamically change the order in which the group of ATM connections circulate through the bridge devices according to the size of the traffic between each two bridge devices.

DEPR:
In addition, in a case the target bridge device accommodating the destination MAC address is apparent, the transfer of the MAC frame can be carried out with the minimum latency (time required for passing) by using the point-to-point ATM connection, unlike a conventional scheme of carrying out the multicast by using the multicast **server**.

DEPR:
Moreover, in the first embodiment, each bridge device has a **table** with the MAC address and the ATM cell header value as each entry, and when the source address of the MAC frame received from the ATM network side interface is not registered in this **table,** this source address and the cell header value for the point-to-point ATM connection connected to the target bridge device of this MAC frame are registered in this **table,** whereas when the destination address of the MAC frame to be transmitted from the ATM network side interface is registered in this **table,** this MAC frame is ATM cell assembled by attaching the cell header value registered in this **table** and transmitted to the ATM network side interface, and when the destination address is either not registered or a broadcast address, this MAC frame is ATM cell assembled by attaching the cell header value for the multicast ATM connection and transmitted to the ATM network side interface, so that the correspondence **table** for the MAC address information and the cell header information can be produced automatically, and the environment for making the efficient bridge interconnections utilizing the point-to-point ATM connections can be constructed automatically.

DEPR:
Furthermore, by providing a correspondence **table** of the cell header value of the multicast ATM connection which has this bridge device as a leaf and the cell header value of the point-to-point ATM connection for interconnecting this bridge device with another bridge device which is a root of the multicast ATM connection, it becomes possible to register the cell header value of the point-to-point ATM connection very conveniently by referring to this **table** at a time of registering the correspondence relationship of the MAC address and the cell header value of the point-to-point ATM connection connected to the bridge device which accommodates the host at that MAC address, even when the MAC frame is received through the multicast ATM connection. As a consequence, even in a case which involves many new **table** registration operations such as a time of activation of the host, in which the MAC frames arrive through the multicast ATM connection set by the ARP request frame first and the registration and

learning of the **table** content according to these MAC frames are to be carried out many times, the cell header value to be registered is the point-to-point ATM connection connected to the bridge device accommodating the host at each MAC address.

DEPR:
Also, the source address of the MAC frame entered from the physical interface with respect to the ATM network is referred, and when the source address of this MAC frame is not registered in a **table** having the MAC addresses and the cell header values as entries, this source address and the cell header value of the ATM connection from which this MAC frame is entered are registered in this **table,** whereas when the destination address of this MAC frame is registered in this **table,** this MAC frame is ATM cell assembled by attaching the cell header value registered in this **table** in correspondence to that destination address and then transmitted to the physical interface with respect to the ATM network, and when the destination address of this MAC frame is not registered in this **table,** this MAC frame is transferred to all the other bridge devices which are bridge interconnected with this bridge device through the ATM network if the source address of this MAC frame is the LAN emulation host, or this MAC frame is discarded if the source address of this MAC frame is the other bridge device. As a result, the correspondence **table** of the MAC address information and the cell header information can be produced automatically, and the environment for making the efficient bridge interconnections utilizing the point-to-point ATM connections can be constructed automatically. Moreover, as there is a mechanism for stop relaying the unnecessary MAC frames, it is possible to prevent the indefinite transmission of the MAC frame between the bridge devices when this MAC frame has the destination address which is not registered in this **table**.

DEPR:
Furthermore, by providing three types of multicast connections including a first multicast connection for interconnecting this bridge device and the emulation hosts directly accommodated by this bridge device, a second multicast connection for interconnecting this bridge device and other bridge devices which are bridge interconnected with this bridge device, and a third multicast connection for interconnecting this bridge device and the other bridge devices which are bridge interconnected with this bridge device as well as the emulation hosts directly accommodated by this bridge device, it becomes possible to realize the distribution of the various types of MAC frames conveniently by using these multicast connections, and it becomes possible to carry out the setting of the **table** or the setting of the environment in the bridge device conveniently.

DEPR:
More specifically, by providing three types of multicast connections including the multicast connection having this bridge device as a starting point and all the LAN emulation hosts directly accommodated by this bridge device as ending points, the multicast connection having this bridge device as a starting point and all the other bridge devices which are bridge interconnected with this bridge device as ending points, and the multicast connection having this bridge device as a starting point and all the other bridge devices which are bridge interconnected with this bridge device as well as all the LAN emulation hosts directly accommodated by this bridge device as ending points, it becomes possible to realize the distribution of the various types of MAC frames conveniently by using these multicast connections, and it becomes possible to carry out the setting of the **table** or the setting of the environment in the bridge device conveniently.

DEPR:
It is to be noted that the bridge interconnection of the LAN emulation **server** in the second embodiment described above are equally applicable to the bridge

interconnections in the third and fourth embodiments.

DEPR:
Also, in the first and second embodiments described above, instead of establishing the point-to-point ATM connections among the bridge devices/LE **servers** in a mesh shape, it is also possible to use a scheme in which one or a plurality of logical spanning trees capable of reaching to all the bridge devices/LE **servers** is constructed, and each link (edge) of the spanning tree is constructed by the ATM connection, such that each bridge device/LE **server** which becomes a node of the spanning tree refers to the destination address of the received MAC frame, and reaches to the target (destination) host by tracing the spanning tree.

DEPR:
It is also to be noted that the LAN emulation **server** described above may be equipped with a multicast **server** function.

CLPR:
3. The ATM bridge device of claim 2, wherein the second transmission means judges whether the host having the destination address of the MAC frame entered from the first interface exists in the first communication network by referring to the MAC addresses stored in the **table** means.

CLPR:
4. The ATM bridge device of claim 1, wherein the first transmission means selectively transmits the MAC frame transmitted from the first interface by referring to the **table** means, such that the MAC frame transmitted from the first interface is transmitted to the point-to-point ATM connection when a destination address of the MAC frame to be transmitted from the first interface is registered as one of the MAC addresses in the **table** means, and the MAC frame transmitted from the first interface is transmitted to the multicast ATM connection when the destination address of the MAC frame to be transmitted from the first interface is not registered as one of the MAC addresses in the **table** means.

CLPR:
5. The ATM bridge device of claim 1, wherein when the MAC frame entered from the first interface arrives from a certain point-to-point ATM connection, the **table** means registers an identifier of said certain point-to-point ATM connection in correspondence to the source address of the MAC frame entered from the first interface in the **table** means, whereas when the MAC frame entered from the first interface arrives from a certain multicast ATM connection, the **table** means registers an identifier of one point-to-point ATM connection estimated as interconnecting said ATM bridge device and another ATM bridge device at a root of said certain multicast ATM connection.

CLPR:
7. The ATM bridge device of claim I, wherein when a destination address of the MAC frame to be transmitted from the first interface is registered as one of the MAC addresses in the **table** means, the first transmission means transmits the MAC frame to be transmitted from the first interface to the first interface by attaching an identifier registered in the **table** means in correspondence to said one of the MAC addresses, whereas when the destination address of the MAC frame to be transmitted from the first interface is not registered as one of the MAC addresses in the **table** means and the destination address of the MAC frame to be transmitted from the first interface is a broadcast address, the first transmission means transmits the MAC frame to be transmitted from the first interface to the first interface by attaching an identifier for the multicast ATM connection.

CLPR:

14. The method of claim 13, wherein at the step (d), whether the host having the destination address of the MAC frame entered from the first interface exists in the first communication network is judged by referring to the MAC addresses stored in the **table** means.

CLPR:
15. The method of claim 12, wherein at the step (c), the MAC frame transmitted from the first interface is selectively transmitted by referring to the **table** means, such that the MAC frame transmitted from the first interface is transmitted to the point-to-point ATM connection when a destination address of the MAC frame to be transmitted from the first interface is registered as one of the MAC addresses in the **table** means, and the MAC frame transmitted from the first interface is transmitted to the multicast ATM connection when the destination address of the MAC frame to be transmitted from the first interface is not registered as one of the MAC addresses in the **table** means.

CLPR:
16. The method of claim 12, wherein at the step (e), when the MAC frame entered from the first interface arrives from a certain point-to-point ATM connection, the **table** means registers an identifier of said certain point-to-point ATM connection in correspondence to the source address of the MAC frame entered from the first interface in the **table** means, whereas when the MAC frame entered from the first interface arrives from a certain multicast ATM connection, the **table** means registers an identifier of one point-to-point ATM connection estimated as interconnecting said ATM bridge device and another ATM bridge device at a root of said certain multicast ATM connection.

CLPR:
18. The method of claim 12, wherein at the step (c), when a destination address of the MAC frame to be transmitted from the first interface is registered as one of the MAC addresses in the **table** means, the MAC frame to be transmitted from the first interface is transmitted to the first interface by attaching an identifier registered in the **table** means in correspondence to said one of the MAC addresses, whereas when the destination address of the MAC frame to be transmitted from the first interface is not registered as one of the MAC addresses in the **table** means and the destination address of the MAC frame to be transmitted from the first interface is a broadcast address, the MAC frame to be transmitted from the first interface is transmitted to the first interface by attaching an identifier for the multicast ATM connection.

CLPV:
table means for storing MAC addresses and identifiers of point-to-point ATM connections related to the stored MAC addresses by registering a source address of each MAC frame entered from the first interface and an identifier of a point-to-point ATM connection corresponding to said each MAC frame; and

CLPV:
a correspondence **table** of (a) an identifier of the multicast ATM connection which has said ATM bridge device as a leaf, and (b) an identifier of the point-to-point ATM connection interconnecting said ATM bridge device and another ATM bridge device which is a root of the multicast ATM connection.

CLPV:
means for registering the source address of each MAC frame and an identifier of a point-to-point ATM connection connected to an ATM bridge device which is a transfer target of each MAC frame into the **table** means when the source address of each MAC frame received from the first interface is not registered in the **table** means yet.

CLPV:
table means for storing MAC addresses and identifiers of ATM connections

related to the stored MAC addresses;

CLPV:
means for registering in the **table** means the source address of the MAC frame entered from the interface and an identifier of an ATM connection which transmitted the MAC frame entered from the interface, when the source address of the MAC frame entered from the interface is not registered in the **table** means yet;

CLPV:
means for transmitting the MAC frame entered from the interface to the interface when a destination address of the MAC frame entered from the interface is registered as one of the MAC addresses in the **table** means, by attaching an identifier registered in the **table** means in correspondence to said one of the MAC addresses; and

CLPV:
means for transferring the MAC frame entered from the interface to other ATM bridge devices which are bridge interconnected with said ATM bridge device through the ATM communication network when the destination address of the MAC frame entered from the interface is not registered in the **table** means yet and the source address of the MAC frame entered from the interface is one of the emulation hosts, and discarding the MAC frame entered from the interface when the source address of the MAC frame entered from the interface is another ATM bridge device.

CLPV:
(e) storing MAC addresses and identifiers of point-to-point ATM connections related to the stored MAC addresses in **table** means by registering a source address of each MAC frame entered from the first interface and an identifier of a point-to-point ATM connection corresponding to said each MAC frame; and

CLPV:
(f) providing a correspondence **table** of (i) an identifier of the multicast ATM connection which has said ATM bridge device as a leaf, and (ii) an identifier of the point-to-point ATM connection interconnecting said ATM bridge device and another ATM bridge device which is a root of the multicast ATM connection.

CLPV:
(g) registering the source address of each MAC frame and an identifier of a point-to-point ATM connection connected to an ATM bridge device which is a transfer target of each MAC frame into the **table** means when the source address of each MAC frame received from the first interface is not registered in the **table** means yet.

CLPV:
(b2-2) providing **table** means for storing MAC addresses and identifiers of ATM connections in correspondences;

CLPV:
(b2-3) registering into the **table** means the source address of the MAC frame entered from the interface and an identifier of an ATM connection which transmitted the MAC frame entered from the interface, when the source address of the MAC frame entered from the interface is not registered in the **table** means yet;

CLPV:
(b2-4) transmitting the MAC frame entered from the interface to the interface when a destination address of the MAC frame entered from the interface is registered as one of the MAC addresses in the **table** means, by attaching an identifier registered in the **table** means in correspondence to said one of the

MAC addresses; and

CLPV:
(B2-5) transferring the MAC frame entered from the interface to other ATM bridge devices which are bridge interconnected with said ATM bridge device through the ATM communication network when the destination address of the MAC frame entered from the interface is not registered in the **table** means yet and the source address of the MAC frame entered from the interface is one of the emulation hosts, and discarding the MAC frame entered from the interface when the source address of the MAC frame entered from the interface is another ATM bridge device.